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Effects of Care Coordination on Hospitalization, Quality of Care, and Health Care Expenditures Among Medicare Beneficiaries

15 Randomized Trials

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CHRONIC ILLNESSES POSE A significant expense to the Medicare program and a major detriment to beneficiaries' quality of life. The cost and complexity of care are greater for those patients with multiple chronic illnesses. In 2002, for example, half of Medicare beneficiaries had been treated for 5 or more conditions but accounted for a disproportionately large 75% of Medicare spending.¹

The high Medicare expenditures generated by these beneficiaries are driven primarily by hospital admissions and readmissions.² Several factors appear to contribute to the high rate of hospitalizations. Chronically ill patients may have received inadequate counseling on diet, medication, and self-care, or may find it hard to adhere to such regimens,³⁻⁹ leading to acute exacerbations of their conditions.¹⁰⁻¹⁵ Patients may lack the knowledge to recognize early warning signs of decompensation or the skills to respond to such signs, or they may not have ready access to medical help other than the emergency department.^{13,16} Physicians may be unaware of patients' deficits in knowledge and skills, or of patients' barriers to adherence.¹⁷⁻¹⁹

For editorial comment see p 668.

Context Medicare expenditures of patients with chronic illnesses might be reduced through improvements in care, patient adherence, and communication.

Objective To determine whether care coordination programs reduced hospitalizations and Medicare expenditures and improved quality of care for chronically ill Medicare beneficiaries.

Design, Setting, and Patients Eligible fee-for-service Medicare patients (primarily with congestive heart failure, coronary artery disease, and diabetes) who volunteered to participate between April 2002 and June 2005 in 15 care coordination programs (each received a negotiated monthly fee per patient from Medicare) were randomly assigned to treatment or control (usual care) status. Hospitalizations, costs, and some quality-of-care outcomes were measured with claims data for 18 309 patients (n=178 to 2657 per program) from patients' enrollment through June 2006. A patient survey 7 to 12 months after enrollment provided additional quality-of-care measures.

Interventions Nurses provided patient education and monitoring (mostly via telephone) to improve adherence and ability to communicate with physicians. Patients were contacted twice per month on average; frequency varied widely.

Main Outcome Measures Hospitalizations, monthly Medicare expenditures, patient-reported and care process indicators.

Results Thirteen of the 15 programs showed no significant ($P < .05$) differences in hospitalizations; however, Mercy had 0.168 fewer hospitalizations per person per year (90% confidence interval [CI], -0.283 to -0.054; 17% less than the control group mean, $P = .02$) and Charlestown had 0.118 more hospitalizations per person per year (90% CI, 0.025-0.210; 19% more than the control group mean, $P = .04$). None of the 15 programs generated net savings. Treatment group members in 3 programs (Health Quality Partners [HQP], Georgetown, Mercy) had monthly Medicare expenditures less than the control group by 9% to 14% (-\$84; 90% CI, -\$171 to \$4; $P = .12$; -\$358; 90% CI, -\$934 to \$218; $P = .31$; and -\$112; 90% CI, -\$231 to \$8; $P = .12$; respectively). Savings offset fees for HQP and Georgetown but not for Mercy; Georgetown was too small to be sustainable. These programs had favorable effects on none of the adherence measures and only a few of many quality of care indicators examined.

Conclusions Viable care coordination programs without a strong transitional care component are unlikely to yield net Medicare savings. Programs with substantial in-person contact that target moderate to severe patients can be cost-neutral and improve some aspects of care.

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Chronically ill patients often see multiple physicians (1 study²⁰ found a median of 7 different physicians per year) who may be incompletely aware of each

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others' care, prescribe incompatible or contraindicated treatments, or provide conflicting advice; often no one physician is responsible for a beneficiary's care.²⁰ Reimbursement under the current Medicare fee-for-service program for education and counseling, care coordination, and ongoing monitoring is limited. Finally, chronically ill beneficiaries often do not receive treatment that has been shown to be effective for their conditions.²¹⁻²³

Studies have thus suggested that interventions to address the barriers faced by chronically ill patients could reduce avoidable hospitalizations and thereby decrease Medicare expenditures. Such interventions might include components to deal with each of the problems listed above by (1) promoting patient-centered care and improving physician-patient communication,^{24,25} (2) increasing patients' adherence to recommended medications and self-care regimens, (3) facilitating greater communication between physicians, and (4) making medical care more evidence-based.²⁶⁻³⁴ Many health plans thus either develop their own care coordination programs or outsource these programs to commercial disease management vendors.^{35,36} A few relatively small, single-center trials of interventions that included some or all of these components have successfully lowered hospitalizations for Medicare patients.^{28,37-40} However, there have been few large, rigorously designed studies of such interventions. Published studies show mixed effects on health outcomes and cost, and it is unclear how these interventions should be designed.^{32,41-46}

To study whether care coordination improves the quality of care and reduces Medicare expenditures, the Balanced Budget Act of 1997 mandated that the Secretary of Health and Human Services conduct and evaluate care coordination programs in the Medicare fee-for-service setting.⁴⁷ The legislation authorized permanent implementation of those demonstration components, if any, that either (1) re-

duced total Medicare expenditures, including program fees; or (2) increased the quality of health care services and satisfaction of beneficiaries and health care organizations without increasing expenditures.

In mid-2000, the Centers for Medicare & Medicaid Services (CMS) solicited proposals for programs to be sites in the Medicare Coordinated Care Demonstration (MCCD). An expert panel convened by CMS reviewed proposals; scored each numerically in the areas of intervention design, organizational capabilities, capacity to implement the intervention (including ability to recruit enough participants to achieve adequate statistical power), and evidence for potential cost-savings and cost-neutrality; ranked the applications; and provided written assessments and recommendations.⁴⁸ The CMS made the final selections and, in early 2002, competitively awarded 15 demonstration programs. In addition, CMS contracted with Mathematica Policy Research Inc (MPR) to conduct the independent evaluation. This analysis summarizes the results from the randomized controlled trials of these 15 programs on how they affected Medicare expenditures and quality of care.

METHODS

Study Populations and Randomization

Each program was allowed to define, within broad boundaries, its own target population and exclusion criteria, and designed its intervention accordingly. Medicare beneficiaries who resided in the programs' catchment areas, were covered by fee-for-service (traditional) Medicare, and had 1 or more of the chronic conditions targeted by the local program were eligible. Chronic conditions selected by the programs included coronary artery disease (CAD), congestive heart failure (CHF), diabetes, chronic pulmonary disease, and other conditions to a lesser extent. (See TABLE 1 for the full list. Because the sample sizes—and hence the power to detect effects—varied, all tables in this manuscript arranged the programs in

3 groups, according to their sample sizes, which were defined post hoc). Ten programs required that enrollees had to be admitted to a hospital (6 programs required that it be for the target condition) within the year before enrollment. Four programs explicitly excluded beneficiaries younger than 65 years and 13 programs excluded those patients with end-stage renal disease or receiving dialysis. Fourteen programs excluded beneficiaries with certain other conditions, including terminal illness, conditions that affected their ability to learn self-management (eg, serious mental illness or dementia), or conditions that were complex to manage but unrelated to target diagnoses (eg, human immunodeficiency virus/AIDS); the specific conditions varied by program. Nine programs also excluded long-term nursing home residents.

Programs began enrolling patients between April and September 2002 and were initially authorized to operate for 4 years. Our study reports on patients enrolled through June 2005. Complete Medicare claims data were available for this study for services rendered through June 2006, the originally planned end of the 4-year demonstration period. The analysis sample was restricted to beneficiaries enrolling through June 2005 to ensure that at least 1 year of follow-up was potentially available for all sample members and that those in the treatment group would have at least 1 year of potential exposure to the intervention.

The Secretary of Health and Human Services, acting through the CMS, determined that the overall demonstration and evaluation met all criteria in both the Common Rule and National Institutes of Health's Exemption Number 5 for exemption from institutional review board review for research and demonstration projects on public benefit and service programs.⁴⁹⁻⁵¹ Mathematica Policy Research Inc has a Federal-wide Assurance of Protection for Human Subjects for demonstrations conducted by governmental agencies. Although neither the legislation nor the

Table 1. Key Demonstration Program Features by Program and Ordered by Enrollment

	Enrollment in Treatment Group Through June 2005														
	≥1150 Patients					400-750 Patients					<115 Patients				
	Carle	CorSolutions	Washington University	Avera	CenVaNet	Charles-town	Health Quality Partners	Hospice of the Valley	Jewish Home and Hospital	Medical Care Development	Mercy Medical Center	QMed	George-town	Quality Oncology	University of Maryland
Host type	IDS	Prov	AMC	Hosp	Prov	RC	Prov	Hospice	LTC	Hosp	Hosp	Prov	AMC	Prov	AMC
State	IL	TX	MO	SD, MN, IA, NE	VA	MD	PA	AZ	NY	ME	IA	CA	DC	FL	MD
Rural location	Yes			Yes			Yes				Yes				
Eligibility criteria															
Required hospitalization ^a	Yes	Yes	NA	Yes		Yes		Yes	Yes	Yes	Yes		Yes		Yes
Any of ^b															
Heart disease	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Diabetes	Yes		NA		Yes	Yes	Yes		Yes						
Other diagnoses	Yes		NA		Yes	Yes	Yes	Yes	Yes	Yes				Yes	
Exclusions at intake ^c															
Age <65 y				Yes	Yes		Yes	Yes							
End-stage renal disease	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Long-term nursing home	Yes	Yes		Yes		Yes	Yes				Yes		Yes	Yes	Yes
Other	CX	CX	CX	SM, CX	SM, CX	CX	SM, CX	CX		SM, CX	CX	CX	CX	CX	SM, CX
Care coordinator staffing															
BSN required ^d									Yes		Yes		Yes		Yes
Caseload	155	145	70	86	75	60	106	40	66	70	50	150	36	40	71
Physician engagement															
Care coordinator near physicians	Yes					Yes	Yes			Yes	Yes				
Physicians paid	Yes	Yes		Yes		Yes			Yes	Yes		Yes	Yes	Yes	Yes
No. of approaches to involving physicians ^e	5	2	1	4	2	2	1	2	3	1	3	4	3	1	1
Intervention Features															
Patient education															
Program provided	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA
Used behavior change model ^f	Yes	Yes	Yes		Yes		Yes	Yes		Yes					NA
Ongoing monitoring															
Used home telemonitor				Yes	Limited				Limited		Limited		Yes		Yes
No. of contacts per member per mo	1.4	2.6	1.2	8.2	1.4	2.3	2.2	2.5	2.5	1.5	1.4	1.2	5.9	NA	3.9
No. of in-person contacts per member per mo	.44	.10	.06	.13	.25	.73	.92	.93	1.01	.44	.97	.09	.83	NA	.25
Improving communication and coordination ^g															
Taught how to communicate with physicians	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	Yes	Yes	Yes	
Timely information on hospital/ER admissions	Yes		Yes	Yes		Yes	Yes		Yes	Yes	Yes		Yes		Yes
Medication information from clinicians			Yes	Yes	Yes	Yes						Yes			
Pharmacist/medical director medication consult			Yes	Yes		Yes		Yes	Yes		Yes	Yes	Yes		
Improving clinician practice															
Focus on improving physician practice	Yes	Yes		Yes								Yes			

(continued)

Table 1. Key Demonstration Program Features by Program and Ordered by Enrollment (continued)

	Enrollment in Treatment Group Through June 2005														
	≥1150 Patients			400-750 Patients								<115 Patients			
	Carle	CorSolutions	Washington University	Avera	CenVaNet	Charles-town	Health Quality Partners	Hospice of the Valley	Jewish Home and Hospital	Medical Care Development	Mercy Medical Center	QMed	George-town	Quality Oncology	University of Maryland
	Program Classification Index Quintiles by Domain ^h														
Program staffing	1	2	3	5	3	3	2	4	5	4	1	5	2	1	4
Initial assessment	2	2	4	2	1	4	1	4	5	3	3	5	1	3	5
Problem identification and care planning	2	2	4	1	4	2	3	3	5	3	1	4	1	5	5
Patient education	2	1	5	2	3	3	1	2	5	4	1	4	3	4	5
Improving communication and coordination	1	4	3	4	3	1	2	2	5	3	1	4	2	5	5
Improving clinician practice	1	1	3	2	3	4	4	5	5	2	5	1	2	3	4
Service and resource arrangement	1	2	1	3	4	5	4	3	1	2	2	4	3	5	5
Information technology and electronic records	1	2	3	4	2	2	5	5	5	3	4	4	3	1	1
Ongoing monitoring	3	2	3	1	1	3	2	4	5	5	4	2	4	1	5
Quality management and outcome measurement	1	3	1	5	2	4	3	3	5	4	4	2	2	1	5

Abbreviations: AMC, academic medical center; BSN, bachelor of science in nursing; ER, emergency department; Hosp, community hospital; IDS, integrated delivery system; LTC, long-term care facility; Prov, provider of disease management, coordinated care, or quality improvement services; NA, not available due to use of proprietary case-finding software (Washington University), poor data-recording (Quality Oncology), or restriction of intervention to home telemonitoring (University of Maryland); RC, retirement community.

^aHospitalization within the year before random assignment and either for a target diagnosis (n=6) or some other diagnosis (n=4).

^bHeart disease included heart failure, coronary artery disease, atrial fibrillation, ischemic heart disease, and hypertensive heart disease. Other diagnoses included chronic lung disease, cerebrovascular or other vascular disease, moderate to severe hyperlipidemia or hypertension, liver disease, renal failure, cancer, serious mental illness, Alzheimer disease, or other cognitive impairment.

^cEnd-stage renal disease included having renal disease treated with dialysis, requiring dialysis, or receiving dialysis. For other exclusions, SM is for conditions that would affect participants' ability to learn self-management (eg, serious mental illness or dementia) and CX is for conditions that were unusually complex to manage (human immunodeficiency virus/AIDS), being a transplant recipient or candidate, or being terminally ill.

^dAll programs except QMed required their care coordinators to be registered nurses (QMed employed registered nurses or experienced licensed practical nurses).

^eFive approaches were focusing on improving physician practice, expecting physicians to participate in care planning, asking physicians to respond to coordinators' queries, asking physicians to call coordinators with new information on the patient, and asking physicians to give coordinators standing orders to adjust medication dosages or order routine tests.

^fIncluded Prochaska's transtheoretical model and motivational interviewing.

^gTimely information on hospital/ER admissions included receiving e-mail or other alerts from the hospitals most patients used, care coordinators regularly reviewing admissions logs, and following up on missed home telemonitoring readings for programs that used the monitors. Medication information from clinicians included physician chart review, asking physicians to review patient medication lists developed by the program, and communicating with pharmacists used by most patients (rather than relying on patient self-reports).

^hBased on the mean values independently developed by 2 evaluator research staff members. Staff consulted program documents, telephone and site visit interview notes, evaluation case studies, and evaluation first-year reports to complete structured assessment forms. The forms asked a series of questions on the 10 domains listed above. Because there were 15 programs, each quintile consists of 3 programs. On each measure, quintile 1 contains the 3 highest values; quintile 5, the 3 lowest values. Less importance or weight should be given to initial assessment and problem identification and care planning because of fair-to-poor correspondence between 2 evaluator staff members on scoring.

US Department of Health and Human Services required certification of institutional review board review for this exempt research, each of the programs decided on its own whether to claim the exemption or to instead seek approval of its protocols from its local institutional review board. All study participants provided written informed consent; each program determined whether proxies could provide consent.

Each program's intake staff recruited patients for its program and transmitted patient information on consenting beneficiaries to MPR's study Web site; MPR checked the information for previous enrollment, completeness, and validity, and then random-

ized eligible applicants within each program to the treatment or control group in a 1:1 ratio, using randomly generated, concealed 4-digit "strings" of treatment-control assignments. Strings with all treatments or all controls were excluded to minimize runs of more than 6 consecutive treatment or control group assignments. The random assignment result was returned within seconds to the program via the Web site. Five programs requested and were allowed to have their patients randomized within program-defined severity of illness strata. Because of the nature of the intervention, no individuals were blinded to which group participants were randomized.

Study Settings and Interventions

The 15 program hosts included 5 commercial disease management companies, 3 community hospitals, 3 academic medical centers, 1 integrated delivery system, 1 hospice, 1 long-term care facility, and 1 retirement community (Table 1). Programs served patients in Maine (statewide); Baltimore, Maryland (2 programs); Washington, DC; eastern Virginia; southern Florida; east central Illinois; St Louis, Missouri; northwestern Iowa and southeastern South Dakota (2 programs); Phoenix, Arizona; New York City; eastern Pennsylvania; Houston, Texas; and 2 counties in central California.

To better understand the programs' activities, MPR reviewed their protocols and documentation and interviewed staff at each program at the end of the first and third years of operations (2003 and 2005). The care coordination interventions of the 15 programs differed widely (described briefly in Table 1 due to space constraints; full descriptions are provided elsewhere⁵²). All of the programs assigned patients to a care coordinator. Although 1 program used licensed practical nurses, all other programs required care coordinators to be registered nurses and 4 programs required them to have bachelor of science in nursing degrees. In all programs, the care coordinators assessed patients' needs and developed patient care plans.

All but 1 of the programs educated patients to improve adherence to medication, diet, exercise, and self-care regimens, mostly through the nurses conveying factual information. Seven programs also used behavior change models such as the transtheoretical approach⁵³ or techniques such as motivational interviewing.⁵⁴ (The University of Maryland program was meant only to test the effect of home telemonitoring and thus did not educate patients or coordinate their care.) Almost all of the programs used standardized curricula and evaluated educational effectiveness, through such means as monitoring clinical indicators, assessing patients' knowledge and self-reported behavior, and having patients repeat or explain information back to the care coordinator. All programs sent physicians regular written reports on patients. However, only 4 programs focused on increasing physicians' adherence to evidence-based or guideline-based care (eg, monitoring microalbuminuria among patients with diabetes or prescribing angiotensin-converting enzyme inhibitors or angiotensin receptor blockers for patients with reduced ejection fraction) (Table 1), in part from the program staff's concerns about burdening and possibly alienating physicians. Most programs referred patients to or

arranged for support services (such as home-delivered meals or transportation), but this was not usually their focus, in part because only a minority of patients required such services.

Fourteen of the 15 programs attempted to improve care coordination (eg, by improving communication between patients and physicians, better managing care setting transitions, and addressing problems of polypharmacy). However, they used different approaches to meet this goal. Twelve programs taught patients to communicate with their physicians more effectively through role-playing and by helping patients articulate their concerns more clearly. Ten programs had timely information on the majority of patient hospitalizations or emergency department encounters; thus, only these programs could systematically intervene with patients at the time of transition. However, procedures for addressing such adverse events tended to be relatively unstructured and not consistently applied. Fourteen programs relied on patients to furnish care coordinators with lists of current medications. Only 4 programs also received this information from other sources, such as medical chart review. When medication problems were identified, care coordinators in 8 programs regularly consulted with pharmacists (or the programs' medical directors) before asking physicians to resolve them.

In addition to qualitatively describing each program's interventions, we also used site visit data and a structured instrument with high interrater reliability to quantitatively score each program's efforts in 10 specific intervention areas, such as patient education, improving physician practice, and health information technology (Table 1).⁵² When interrater and interobserver reliability were assessed, 5 of the 10 domains had intraclass correlation coefficients of excellent (range, 0.82-0.93) and 2 were good (0.69 and 0.80, respectively).⁵²

The caseloads of care coordinators for half of the programs ranged between 40 and 70 patients. Eleven programs con-

tacted patients 1 to 2.5 times per month, but 3 programs contacted patients 4 to 8 times per month (the other program did not record all contacts). All programs contacted patients primarily by telephone; however, 4 programs contacted patients in person nearly once a month as well. In 13 programs, at least 85% of contacts were initiated by care coordinators. Six programs (3 for all patients and 3 only for selected patients) used home telemonitoring devices for daily transmission of physiological readings and symptom reports.

The CMS paid each program a negotiated fixed fee ranging from \$80 to \$444 per member per month, with an average of \$235. The CMS limited the fees of the programs to 20% or less of the projected average monthly Medicare expenditures of the target population, because prior literature suggested larger savings were unlikely.^{55,56} The actual amounts paid to the programs over the follow-up, which were lower than the negotiated rates because patients who disenrolled remained in the study, ranged from \$60 to \$270 per member per month, with an average of \$164.

Data

Data on hospital admissions and Medicare expenditures were obtained from the Medicare Standard Analytic File. The Medicare National Claims History File provided data on all other services used and the program fees paid. Patient characteristics and eligibility for Medicare were taken from the Medicare Enrollment Database. A computer-assisted telephone survey of patients conducted by MPR in each of the 12 programs with sufficient enrollment for analysis provided data on patient behavior, health outcomes, and satisfaction with health care. Approximately 350 patients in the treatment group and 350 patients in the control group in each of 7 programs were randomly selected for the survey (in the 5 programs with 400 to 700 total study patients, all were included) 12 to 18 months after program start-up and were interviewed approximately 10 months

after their randomization date. The survey response rates for all 12 programs were very high (mean, 95%) and were very similar for the treatment and control groups.

The patients who were surveyed are generally comparable with those who were not (eTable 1; available at <http://www.jama.com>). The patients selected for the survey were those enrolled in the first 12 months of the program, so the small differences reflect changes in composition of enrollees and the secular increases in Medicare expenditures over time. For all 15 programs, MPR selected and interviewed by telephone a sample of physicians caring for enrolled patients.³² A total of 1018 physicians were surveyed and the overall response rate was approximately 64%. The 25% of surveyed physicians who were not familiar with the program were not interviewed further. The survey instrument examined 8 areas, including physicians' opinions about the program's perceived effects, physician rating of care coordinators' clinical competence, and an overall assessment of the program.

Outcome Measures

Outcome measures drawn from Medicare claims data included postenrollment Medicare hospital use, Part A and B Medicare expenditures, and program fees covering the period from enrollment through June 2006. The study did not collect information on non-Medicare-covered expenditures such as those covered by Medicaid, private or supplemental insurance, or beneficiary out-of-pocket payments. Prescription drug expenditures were not available (and were not covered by Medicare during the study period). All outcome measures were prespecified in a detailed study design protocol.⁵⁷

Medicare claims data were also used to construct 6 disease-specific and 2 general preventive clinical service quality-of-care process measures. The beneficiary survey also collected data on several broad categories of quality-of-care process measures: receipt of health education, receipt of service arrangement as-

sistance, and general preventive clinical services; most of these categories included several measures. Quality-of-care outcome measures in the survey included patients' knowledge and adherence, unmet needs, functional status, and health-related quality of life (with each category again consisting of several measures). Finally, quality-of-care outcome measures from Medicare claims data consisted of 8 different types of general and disease-specific hospitalizations that are thought to be preventable with good quality primary care (also known as potentially preventable hospitalizations or ambulatory care-sensitive conditions).⁵⁸⁻⁶⁰

Statistical Analysis

Effects were calculated using prespecified analyses and an intention-to-treat design that included all sample members randomized to the treatment and control groups regardless of whether they actually participated in the intervention. Results were calculated for each program separately because the 15 interventions, their target populations, and their practice environments differed widely. Two-tailed statistical tests were conducted by using SAS version 9.1 (SAS Institute Inc, Cary, North Carolina). A $P < .10$ level was used to test outcomes rather than a $P < .05$ level because we were concerned with type II as well as type I errors and, in the event that no or few programs were effective at the $P < .05$ level, we wanted to be sure that potentially effective programs at the $P < .10$ level were identified. Examination of related outcomes was used to help assess whether differences significant at only the $P < .10$ level were likely due to chance or true effects.

Given the mandated focus on total Medicare expenditures (including program fees), the study assessed whether each program generated savings in regular Medicare expenditures for Part A and B services, and whether those savings were sufficient to cover the program's fees. The analyses of number of hospitalizations and Medicare expenditures included all beneficiaries enrolled in the study through June 2005

for whom the program had provided a correct Medicare Health Insurance Claim number ($<0.1\%$ of cases were excluded). Mean annualized hospitalizations and expenditures per month were measured from program enrollment through June 2006 or until the sample member died or became ineligible (ie, was no longer covered under both Medicare Parts A and B, no longer had Medicare as the primary payer, or enrolled in a Medicare managed care plan). Observations were weighted to reflect the number of months for which the sample member met these criteria. The analyses of claims-based quality-of-care measures included all beneficiaries enrolled in the study through June 2004 and outcomes were measured over the first 24 months after program enrollment or until the sample member died or became ineligible. The claims-based quality-of-care measures were all binary; cases in which no event was observed were weighted to reflect the proportion of the 24-month follow-up for which the sample member met these criteria but cases in which an event was observed were given a weight of 1.

Treatment-control comparisons of hospitalizations, expenditures, and claims-based quality-of-care measures were regression-adjusted by using ordinary least squares; logistic regression was used for the quality-of-care binary outcomes (eg, whether or not someone received a service). The regression controlled for age, sex, race, original reason for Medicare entitlement, whether the sample member also enrolled in Medicaid, Medicare expenditures per month over the 2 years before randomization, whether the sample member used specific services over that period (home health care, skilled nursing facility, hospital services), and prior diagnoses on claims for 10 chronic conditions (CAD, CHF, stroke, diabetes, cancer, chronic obstructive pulmonary disease, dementia, peripheral vascular disease, depression, and asthma).

To address the problem of multiple test bias, given the large number of outcome measures examined for quality of

care, we grouped outcomes by domain. Statistically significant treatment-control differences (at the 5% level) in any domain were not considered meaningful unless their number exceeded 5% of the outcomes included in that domain (the number expected to occur by chance) and were all in the same direction (either all favoring the treatment group or the control group, in contrast to the roughly equal numbers of differences expected to favor both groups by chance alone).

Twelve of the 15 programs (all except Georgetown, Quality Oncology, and University of Maryland) had sample sizes large enough to yield power of 65% to

99% to detect effects of 20% or more on number of hospitalizations and on Medicare expenditures without program fees. Thus, the evaluation was likely to detect sizable true effects, such as those that were being touted by disease management programs at the time the demonstration began.^{61,62} Given the need to cover program fees and the desire to find programs that generate net savings, this power was sufficient for addressing the primary questions. However, to reduce the likelihood that smaller effects were overlooked, we also examined the treatment-control differences in hospitalizations and expenditures to identify sites with sizable differences in both *P* val-

ues just above the .10 level used in testing, recognizing that this step could further increase the chance for type I error (finding an association where no true association existed).

RESULTS

Compared with all Medicare beneficiaries, enrollees had higher educational levels and were less likely to be Hispanic, younger than 65 years, or be enrolled in Medicaid (a proxy for poverty) (TABLE 2). This reflects a combination of where the programs operated, their eligibility criteria, and which beneficiaries chose to enroll. The most common conditions for which the

Table 2. Baseline Characteristics of Patients Enrolled Through June 2005^a

Characteristics	Treatment Group Members Enrolled Through June 2005, %																Medicare Total in 2003 (N = 42.3 million)	
	≥1150 Patients				400-750 Patients							90-115 Patients				%		
	Carle (n = 2657)	CorSo-lutions (n = 2646)	Wash-ington Univer-sity (n = 2289)	Avera (n = 858)	CenVa-Net (n = 1445)	Charles-town (n = 830)	Health Quality Part-ners (n = 1466)	Hos-pice of the Valley (n = 1048)	Jewish Home and Hospi-tal (n = 872)	Medi-cal Care Devel-op-ment (n = 1329)	Mercy Medi-cal Center (n = 934)	QMed (n = 1406)	Georgetown Univer-sity (n = 230)	Quality Oncol-ogy (n = 211)	Univer-sity of Mary-land (n = 181)	All pro-grams (N = 18 402)		
Age, y																		
<65	2.0	14.7	26.7	0	0	0	0	0	0.1	6.1	4.3	8.5	1.7	7.1	13.8	7.3	14.4	
≥85	11.3	12.5	9.8	20.0	12.0	43.5	7.0	26.5	38.2	11.5	17.1	5.0	15.7	12.8	5.5	14.9	11.1	
Male sex	47.5	38.1	45.3	52.0	56.5	34.5	39.7	41.2	23.4	50.6	54.6	44.5	44.8	45.5	70.2	44.6	44.0	
Race/ethnicity																		
Black, non-Hispanic	3.1	30.5	36.8	0.1	14.9	0.5	0.8	1.2	26.8	0	0.1	5.1	63.0	8.5	42.0	13.7	9.5	
Hispanic	0	3.8	0.1	0	0.1	0.1	0	0.9	9.7	0	0.1	2.2	1.3	5.2	0	1.3	7.8	
Medicaid	5.3	27.9	19.1	8.2	4.8	0	1.8	16.1	25.6	20.7	11.6	13.7	21.3	13.7	14.4	13.9	19.3	
<High school education	14.3	36.3	25.3	34.0	25.7	10.2	10.6	18.1	31.5	32.0	29.7	19.7	NA	NA	NA	23.5	30.4	
Diagnosis																		
CAD	45.5	83.5	54.8	75.4	73.4	54.9	34.0	60.4	48.6	78.3	64.1	48.6	80.9	46.0	76.2	60.5	40.5 ^b	
CHF	24.7	96.4	41.5	96.7	47.8	43.4	10.6	51.4	31.3	48.5	60.1	18.1	96.1	18.0	86.7	48.3	40.5 ^b	
Diabetes	38.5	55.0	42.2	40.0	50.7	25.1	24.3	30.9	33.4	41.6	33.3	25.5	54.8	25.1	45.3	39.0	20.6	
COPD	21.1	49.8	31.4	42.5	27.9	36.4	12.8	49.9	20.9	31.8	52.9	14.3	40.0	32.2	40.3	32.1	15.3	
Cancer	20.8	16.9	35.9	23.7	27.7	32.3	22.2	31.2	28.0	19.0	23.6	19.8	23.9	94.3	11.6	25.1	17.3	
Stroke	13.5	40.1	23.7	21.1	26.4	32.0	14.2	35.2	27.2	17.3	26.1	14.0	28.3	14.2	24.3	24.0	12.1	
Depression	13.1	21.9	23.4	14.5	10.9	18.7	8.3	22.7	30.7	16.9	24.2	9.5	14.3	10.9	12.2	17.3	NA	
Dementia	5.1	12.3	11.5	4.0	4.8	8.4	1.8	23.5	33.1	2.3	6.3	1.6	12.2	5.7	4.4	8.8	5.2 ^b	
Medical use during the year before randomization																		
No. of annualized hospitalizations	0.52	2.60	1.88	2.18	0.76	0.89	0.32	1.65	0.86	1.38	1.43	0.30	3.01	0.88	2.28	1.31	0.30	
Monthly expenditures, \$	590	2934	2311	1725	862	1108	476	2059	1629	1495	1356	539	2898	2303	2945	1535	552	

Abbreviations: CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; NA, not available.

^aBased on Medicare National Claims History File, Standard Analytic File, and Enrollment Database for estimates of demonstration enrollees. For Medicare total in 2003, estimates were based on the Medicare Current Beneficiary Survey 2003 and Medicare and Medicaid Statistical Supplement 2005. Less than high school education was collected from the patient survey conducted by Mathematica Policy Research Inc on a sample of enrollees through June 2004. Diagnoses are medical conditions noted on Medicare claims during 2 years before randomization. Cancer excludes skin cancer.

^bData are not directly comparable. For Medicare totals, data are reported as heart disease, which includes both CAD and CHF. Medicare total data reported under dementia includes Alzheimer disease.

Table 3. Baseline Treatment-Control Differences Among Patients Randomized Through June 2005^a

Table 1. Baseline Treatment Contrast Differences Among Patients Randomized Through June 2005																	
	Characteristics, %															Medical Use During the Year Before Randomization	
	Age, y		Male Sex	Race		Diagnosis											
	<65	≥85		Black, Non- His- panic	His- panic	Medic- aid	<High School Educa- tion	CAD	CHF	Diabe- tes	COPD	Cancer	Stroke	De- pres- sion	De- mentia	No. of Annu- alized Hospi- taliza- tions	Monthly Expen- ditures, \$
≥1150 Treatment Group Members Enrolled Through June 2005																	
Carle																	
Treatment (n = 1338)	2.4	11.0	46.3	2.5	0	5.4	14.2	44.5	25.6	38.9	21.9	21.7	13.2	12.9	5.0	0.5	614
Control (n = 1319)	1.7	11.6	48.6	3.6	0	5.2	14.5	46.5	23.7	38.1	20.4	19.9	13.8	13.3	5.2	0.5	566
CorSolutions																	
Treatment (n = 1511)	14.0	12.6	38.4	30.0	3.8	27.4	39.5	83.8	96.6	53.9	50.7	16.7	40.6	20.5	10.9	2.5	2874
Control (n = 1135)	15.6	12.3	37.8	31.2	3.9	28.5	31.9	83.1	96.2	56.5	48.7	17.2	39.5	23.8	14.2	2.7	3015
Washington University																	
Treatment (n = 1150)	25.9	11.0	44.5	37.8	0.2	19.7	26.9	55.1	42.6	40.4	32.3	37.7	24.3	23.6	12.3	1.9	2305
Control (n = 1139)	27.6	8.6	46.2	35.7	0.1	18.4	23.6	54.5	40.5	44.0	30.5	34.0	23.1	23.3	10.8	1.9	2317
400-750 Treatment Group Members Enrolled Through June 2005																	
Avera																	
Treatment (n = 430)	0	20.9	53.5	0.2	0	7.4	32.1	78.6	96.7	40.2	41.6	24.2	20.0	15.1	3.5	2.2	1792
Control (n = 428)	0	19.2	50.5	0	0	8.9	35.9	72.2	96.7	39.7	43.5	23.1	22.2	13.8	4.4	2.2	1658
CenVaNet																	
Treatment (n = 722)	0	11.9	54.8	14.8	0	5.3	27.7	73.7	47.6	50.0	28.0	27.6	26.3	11.6	4.7	0.8	912
Control (n = 723)	0	12.2	58.2	14.9	0.1	4.3	23.7	73.2	47.9	51.5	27.8	27.8	26.6	10.1	4.8	0.7	811
Charlestown																	
Treatment (n = 413)	0	44.3	34.1	0.2	0	0	13.7	54.5	45.0	23.2	36.8	30.5	32.2	20.6	9.9	0.9	1055
Control (n = 417)	0	42.7	34.8	0.7	0.2	0	6.5	55.4	41.7	26.9	36.0	34.1	31.9	16.8	7.0	0.9	1161
Health Quality Partners																	
Treatment (n = 740)	0	7.3	39.2	0.4	0	1.8	9.7	33.4	10.8	25.4	12.7	21.6	15.4	7.7	2.2	0.3	489
Control (n = 726)	0	6.7	40.2	1.2	0	1.8	11.5	34.6	10.5	23.1	12.9	22.9	12.9	8.8	1.5	0.3	462
Hospice of the Valley																	
Treatment (n = 531)	0	28.4	41.4	1.7	0.9	16.9	16.2	59.3	50.7	31.3	48.0	30.9	33.3	23.0	21.8	1.6	2080
Control (n = 517)	0	24.6	41.0	0.8	0.8	15.3	20.1	61.5	52.2	30.6	51.8	31.5	37.1	22.4	25.1	1.7	2037
Jewish Home and Hospital																	
Treatment (n = 435)	0.2	37.5	22.1	26.4	9.2	26.7	33.3	52.2	32.9	33.8	24.6	27.4	30.1	32.0	32.9	0.8	1637
Control (n = 437)	0	38.9	24.7	27.2	10.3	24.5	29.6	45.1	29.7	33.0	17.2	28.6	24.3	29.5	33.4	0.9	1621
Medical Care Development																	
Treatment (n = 669)	6.9	11.8	50.8	0	0	19.6	36.5	78.5	50.4	41.1	34.4	18.2	17.9	19.6	2.2	1.4	1563
Control (n = 660)	5.3	11.2	50.3	0	0	21.8	27.5	78.0	46.7	42.1	29.1	19.7	16.7	14.2	2.4	1.3	1425
Mercy Medical Center																	
Treatment (n = 467)	4.5	16.5	54.0	0.2	0	11.8	26.7	63.0	59.5	31.7	55.0	22.7	26.6	22.5	6.0	1.5	1381
Control (n = 467)	4.1	17.8	55.2	0	0.2	11.3	32.7	65.3	60.6	34.9	50.7	24.4	25.7	25.9	6.6	1.4	1331
Qmed																	
Treatment (n = 707)	8.2	4.4	44.4	4.5	2.1	13.7	21.5	49.6	17.5	24.9	15.6	20.5	12.9	9.6	1.3	0.3	581
Control (n = 699)	8.9	5.7	44.5	5.7	2.3	13.7	17.9	47.5	18.7	26.2	13.0	19.2	15.2	9.4	1.9	0.3	496

(continued)

Table 3. Baseline Treatment-Control Differences Among Patients Randomized Through June 2005^a (continued)

	Characteristics, %															Medical Use During the Year Before Randomization	
	Age, y		Male Sex	Race		Medic-aid	<High School Education	Diagnosis								No. of Annualized Hospitalizations	Monthly Expen-ditures, \$
	<65	≥85		Black, Non-His-panic	His-panic			CAD	CHF	Diabe-tes	COPD	Cancer	Stroke	Depres-sion	De-mentia		
90-115 Treatment Group Members Enrolled Through June 2005																	
Georgetown University Treatment (n = 115)	2.6	14.8	47.0	63.5	1.7	19.1	0	80.9	95.7	54.8	33.9	21.7	27.0	13.0	12.2	2.9	2772
Control (n = 115)	0.9	16.5	42.6	62.6	0.9	23.5	0	80.9	96.5	54.8	46.1	26.1	29.6	15.7	12.2	3.1	3024
Quality Oncology Treatment (n = 107)	5.6	13.1	51.4	9.3	6.5	14.0	0	49.5	19.6	23.4	28.0	95.3	15.0	10.3	8.4	0.8	2259
Control (n = 104)	8.7	12.5	39.4	7.7	3.8	13.5	0	42.3	16.3	26.9	36.5	93.3	13.5	11.5	2.9	0.9	2349
University of Maryland Treatment (n = 92)	12.0	5.4	70.7	42.4	0	18.5	0	76.1	87.0	50.0	39.1	9.8	28.3	13.0	3.3	2.5	3001
Control (n = 89)	15.7	5.6	69.7	41.6	0	10.1	0	76.4	86.5	40.4	41.6	13.5	20.2	11.2	5.6	2.1	2888
All Programs																	
Treatment (n = 9427)	7.3	15.0	44.2	13.9	1.4	14.2	24.6	61.2	49.7	38.9	33.1	25.0	24.5	17.5	8.7	1.3	1570
Control (n = 8975)	7.3	14.7	45.0	13.5	1.3	13.5	22.3	59.8	46.8	39.2	31.1	25.1	23.5	17.2	9.0	1.3	1498

Abbreviations: CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

^aSee footnotes of Table 2. Medicare total in 2003 data are the same as in Table 2 for all characteristics.

study sample had been treated in the 2 years before enrollment were CAD (61%), CHF (48%), diabetes (39%), and chronic obstructive pulmonary disease (32%); 17% were treated for depression (Table 2). Most of the programs enrolled high-cost patients; preenrollment Medicare expenditures averaged more than \$2000 per month during the year before enrollment for the research sample in 6 programs, but less than \$600 per month for 3 other programs. The average monthly Medicare expenditure of \$1535 for the research sample overall was nearly 3 times that of beneficiaries nationwide (\$552 per month in 2003).⁶³ Across all of the 15 programs and the baseline characteristics shown in Table 2, the treatment and control groups differed significantly on only 11 of the 255 comparisons at the $P < .05$ level, less than the expected number of statistically significant differences that would be observed by chance (TABLE 3).

The maximum number of follow-up months was 51; on average,

members of the research sample had 30 months of eligibility during follow-up. Programs varied widely in their patients' average length of potential exposure to the program, with a range of 18 to 38 months (TABLE 4).

Hospitalizations

Two programs had treatment-control differences in the number of annual hospitalizations that were significant at the 5% level. Mercy reduced annual hospitalizations by 0.168 per person per year (17% of the control group mean, $P = .02$) (Table 4). The Charlestown program had an increase of 0.118 hospitalizations per person per year or 19% more than the control group mean ($P = .04$). In addition, Georgetown reduced annual hospitalizations by 0.494 per person per year (24% of the control group mean, $P = .07$).

Medicare Expenditures, With and Without Program Fees

None of the programs reduced regular Medicare expenditures, even without the

fees paid to the care coordination programs (TABLE 5). Only 2 programs had a significant difference in expenditures and, in both of these programs, the treatment group had higher expenditures (Charlestown by \$186 per member per month [19%, $P = .03$] and Carle by \$61 per member per month [9%, $P = .08$]). For 2 programs, the treatment group had substantially lower expenditures than the control group (monthly treatment group expenditures for Health Quality Partners [HQP] were \$84 [12%] lower than those of the control group; monthly treatment group expenditures for Mercy were \$112 [9%] lower than those of the control group). However, these differences were not statistically significant ($P = .12$ for each). As a sensitivity test, we calculated the effects on expenditures after trimming the values of outlier cases to the value for the 98th percentile of that program's sample members (available upon request). Mercy's 9% reduction ($P = .12$) increased to 10% and became significant using the 10% level ($P = .07$). Using the

logarithm of cost to reduce the variance of estimates inflated by outliers led to increases in precision similar to those obtained from trimming the outliers. Results for HQP did not change substantially.

For total Medicare expenditures including program fees, the treatment groups for 9 programs had 8% to 41% higher total expenditures than the control groups did, all statistically significant ($P < .05$) (Table 5). However, one

of these programs, Mercy, had 17% fewer hospitalizations in the treatment group than in the control group ($P = .02$), and 9% lower monthly Medicare Part A and B expenditures (\$112, $P = .12$). The Mercy program received

Table 4. Power and Regression-Adjusted Effects on Annualized Hospital Admissions Through June 2006 Among Patients Randomized Through June 2005^a

	Mean No. of Follow-up Months Through June 2006	Power to Detect a 20% Effect on Hospitalizations	Annualized No. of Hospital Admissions			
			Control Group	Treatment-Control Difference (90% Confidence Interval)	% Difference	P Value
≥1150 Treatment Group Members Enrolled Through 2005						
Carle	37.0	0.98	0.525	0.022 (−0.026 to 0.070)	4.2	.45
CorSolutions	25.2	0.99	1.777	−0.057 (−0.174 to 0.059)	−3.2	.42
Washington University	29.3	0.99	1.367	−0.019 (−0.129 to 0.092)	−1.4	.78
400-750 Treatment Group Members Enrolled Through 2005						
Avera	25.4	0.82	1.369	−0.025 (−0.199 to 0.150)	−1.8	.82
CenVaNet	35.2	0.88	0.657	0.039 (−0.038 to 0.116)	5.9	.41
Charlestown	30.5	0.71	0.618	0.118 (0.025 to 0.210)	19.0	.04
Health Quality Partners	30.1	0.74	0.433	−0.049 (−0.111 to 0.012)	−11.4	.19
Hospice of the Valley	20.4	0.89	1.352	−0.097 (−0.253 to 0.059)	−7.2	.31
Jewish Home and Hospital	30.8	0.68	0.854	0.096 (−0.037 to 0.229)	11.2	.24
Medical Care Development	26.2	0.92	1.454	−0.050 (−0.207 to 0.107)	−3.4	.60
Mercy Medical Center	32.6	0.88	0.984	−0.168 (−0.283 to −0.054)	−17.1	.02
QMed	37.7	0.81	0.406	0.006 (−0.047 to 0.059)	1.4	.86
90-115 Treatment Group Members Enrolled Through 2005						
Georgetown University	27.7	0.48	2.057	−0.494 (−0.919 to −0.069)	−24.0	.07
Quality Oncology	18.4	0.22	1.113	0.049 (−0.366 to 0.463)	4.4	.85
University of Maryland	23.5	0.27	2.151	−0.156 (−0.833 to 0.521)	−7.3	.70

^aBased on Medicare Enrollment Database, National Claims History File, and Standard Analytic File. Treatment and control group members who do not meet the demonstration-wide requirements of the Centers for Medicare & Medicaid Services (CMS) or who had an invalid Health Insurance Claim number on the Mathematica Policy Research Inc's enrollment file are excluded because Medicare data showing their payments in the fee-for-service program were not available. Members of the same households as the research sample members are also excluded ($n = 990$). The outcomes are weighted according to the proportion of follow-up during which each sample member meets CMS's demonstration-wide requirements and is alive. The requirements of CMS are being in fee-for-service, having both Part A and Part B coverage, and having Medicare as the primary payer. Weights are calculated separately for the treatment and control groups.

Table 5. Power and Regression-Adjusted Effects on Medicare Expenditures Through June 2006 Among Patients Randomized Through June 2005^a

	Mean Program Fee Received, \$	Power to Detect a 20% Effect on Expenditures	Monthly Medicare Expenditures, \$						
			Regular (Without Program Fees)				Total (With Program Fees)		
			Control Group	Treatment-Control Difference (90% Confidence Interval)	% Difference	P Value	Treatment-Control Difference (90% Confidence Interval)	% Difference	P Value
≥1150 Treatment Group Members Enrolled Through 2005									
Carle	148	0.99	695	61 (4 to 117)	8.7	.08	209 (153 to 265)	30.1	<.001
CorSolutions	215	0.99	2596	15 (−173 to 202)	0.6	.90	213 (25 to 400)	8.2	.06
Washington University	155	0.99	1904	86 (−63 to 235)	4.5	.34	245 (96 to 395)	12.9	.007
400-750 Treatment Group Members Enrolled Through 2005									
Avera	270	0.84	1391	−38 (−210 to 134)	−2.7	.72	236 (65 to 408)	17.0	.02
CenVaNet	72	0.93	854	39 (−50 to 128)	4.6	.47	111 (22 to 200)	13.0	.04
Charlestown	215	0.77	996	186 (48 to 323)	18.6	.03	405 (267 to 542)	40.6	<.001
Health Quality Partners	103	0.84	700	−84 (−171 to 4)	−11.9	.12	19 (−68 to 107)	2.8	.72
Hospice of the Valley	177	0.97	2071	19 (−178 to 216)	0.9	.87	199 (3 to 396)	9.6	.10
Jewish Home and Hospital	227	0.74	1710	170 (−75 to 414)	9.9	.25	393 (148 to 637)	23.0	.01
Medical Care Development	134	0.92	1666	−100 (−281 to 80)	−6.0	.36	28 (−153 to 209)	1.7	.80
Mercy Medical Center	236	0.95	1198	−112 (−231 to 8)	−9.3	.12	134 (15 to 252)	11.1	.07
QMed	83	0.84	744	−17 (−110 to 76)	−2.2	.77	67 (−26 to 160)	9.0	.24
90-115 Treatment Group Members Enrolled Through 2005									
Georgetown University	240	0.43	2561	−358 (−934 to 218)	−14.0	.31	−112 (−688 to 464)	−4.4	.75
Quality Oncology	60	0.47	3419	−38 (−757 to 681)	−1.1	.93	28 (−691 to 746)	0.8	.95
University of Maryland	268	0.13	2762	975 (−735 to 2685)	35.3	.35	1252 (−459 to 2963)	45.4	.23

^aSee footnote of Table 4.

a large fee of \$236 per member per month, resulting in a net increase in total expenditures of \$134 or 11% ($P=.07$) relative to the control group.

The 90% confidence intervals (CIs) on the treatment-control difference in total expenditures are indistinguishable statistically from zero for the remaining 6 programs (HQP, Medical Care Development, QMed, Georgetown, Quality Oncology, and University of Maryland). We cannot reject the hypothesis that those 6 programs may have been cost-neutral (ie, the savings in regular Medicare expenditures might be enough to offset the program fees). Among these 6 programs, the treatment group at Georgetown had 24% fewer hospitalizations than the control group did and 14% (\$358) lower Medicare expenditures, excluding fees ($P=.31$), more than enough to offset the program fee it received of \$240, but the program was small and could not be sustained. Health Quality Partners had lower hospitalization rates and Medicare expenditures without program fees for the treatment group of 11% and 12%, respectively, but the comparisons were not statistically significant ($P=.19$ and $P=.12$). In addition, the 90% CI of $-\$68$ to $\$107$ around the difference between treatment and control groups is consistent with either an increase or a decrease in Medicare cost. The pattern of evidence, including lack of effects on hospitalizations, suggests cost neutrality is quite unlikely for the other 4 programs (Medical Care Development, QMed, and the small Quality Oncology program clearly had no effects on hospitalizations and University of Maryland's program had expenditures 35% higher in the treatment group than in the control group).

Quality of Care

The patient survey collected information on several process-of-care quality measures. Treatment group members were approximately 1.3 to 2.6 times (6.1 to 40 percentage points) more likely than control group members to recall receiving education during the preceding 12 months on diet, exercise, and

warning signs of disease exacerbation, and receiving educational materials (TABLE 6). Treatment group members were also much more likely to report having received help in arranging care. Results for the other process measures were less uniformly positive, with only a few scattered effects for self-reported influenza and pneumococcal vaccinations, mammography (measured using Medicare claims data), and various routine tests in the care of diabetes and CAD (measured using claims data) (Table 6).

For the survey-based outcomes-of-care measures, despite reporting much higher rates of being taught self-management skills, treatment group members were no more likely than control group members to say they understood proper diet and exercise, or to state that they were adhering to prescribed or recommended diet, exercise, and medications (eTable 2). The treatment group had only a few favorable differences of modest size for functioning, measured using activities of daily living and instrumental activities of daily living, and health-related quality of life, such as freedom from emotional distress or pain, or the 12-Item Short Form Health Survey physical component score. Among the outcomes-of-care measures ascertained from Medicare claims data, no sustained pattern for any programs emerged that suggested that potentially preventable hospitalizations had been reduced.

Because only 2 programs, HQP and Mercy, had sizable enrollments and large treatment-control differences in regular Medicare expenditures, we will focus on these 2 remaining programs. Both programs had significantly more patients in the treatment group than in the control group reporting they received health education on diet, received help in arranging care, and had been taught about exercise, medication use, warning signs, and provision of educational materials (Table 6). Both HQP and Mercy increased treatment group members' satisfaction with specific aspects of their regular health care,

such as physicians keeping in touch with each other and explanations of treatment, with $P<.10$ but $P>.05$ for the comparisons (eTable 2). Like most of the other programs, no overall improvements in patient behaviors, quality of life, activity of daily living, instrumental activity of daily living, or preventable hospitalizations were observed for HQP. For Mercy, there were improvements in only 7 of the 39 measures, including ability to bathe independently, whether felt calm or peaceful most of the time, and preventable hospitalizations for CHF (all with $P<.10$ but $P>.05$).

Physicians generally believed that the programs had favorable effects on their practices, such as by decreasing paperwork and telephone traffic, and increasing quality of care. Physicians valued care coordinators' progress reports on patients and found the programs helpful in arranging transportation, meals, and therapy for patients. Physicians did not think programs helped much with specialist appointments or expensive prescription medications, and they had mixed opinions on programs' abilities to coordinate care with other physicians, foster continuity of care, reduce duplicate testing, or improve communication with family members. Physicians did not believe that programs improved patients' self-management behaviors. Overall, physicians thought the programs produced few negative effects and generally liked them.⁵²

COMMENT

Our results suggest that care coordination, as practiced by the programs participating in the demonstration from 2002 to 2006, holds little promise of reducing total Medicare expenditures for beneficiaries with chronic illnesses. Only 2 programs (Mercy Medical Center and Georgetown) had favorable statistically significant treatment-control differences in hospitalizations and sizable differences (-9.3% and -14.0% , respectively) in Medicare expenditures. However, the Georgetown program was not viable, enrolling only 230 patients over the first 3 years of program

operations (approximately one-third of the target for the first year) and dropped out of the demonstration after 3.5 years. One other program, HQP, also showed promise, with both hospitalizations and expenditures approximately 11% lower

for the treatment group than the control group. Further exploration of the findings for this program, which risk-stratified its patients at enrollment, showed that these treatment-control differences were concentrated en-

tirely in the program's highest severity cases, comprising approximately 30% of the sample, for which the control group's average expenditures were approximately \$900 per member per month (data available from authors on

Table 6. Process of Care Quality Indicators From Patient Survey and Medicare Claims Data^a

	Carle	CorSo- lutions ^b	Wash- ington Univer- sity	Avera	CenVa- Net	Charles- town	Health Quality Part- ners	Hos- pice of the Valley	Jewish Home and Hospi- tal	Medi- cal Care Devel- opment	Mercy Medi- cal Center	QMed	George- town Univer- sity	Univer- sity of Mary- land
Patient Survey Response Rates and Sample Sizes														
Response rates, No. (%)														
Treatment	340 (96.6)	359 (94.8)	317 (94.4)	196 (96.1)	330 (94.6)	285 (95.6)	342 (98.8)	206 (92.2)	248 (87.1)	263 (94.3)	329 (97.9)	328 (95.4)	NA	NA
Control	344 (98.6)	261 (91.7)	306 (94.0)	199 (97.6)	322 (94.2)	277 (93.6)	333 (97.9)	208 (92.2)	235 (83.2)	269 (96.8)	320 (96.1)	330 (96.2)	NA	NA
Overall	684 (97.6)	620 (93.5)	623 (94.2)	395 (96.8)	652 (94.4)	562 (94.6)	675 (98.4)	414 (92.2)	483 (85.1)	532 (95.6)	649 (97.0)	658 (95.8)	NA	NA
Receipt of Health Education (From Patient Survey)														
Beneficiary reported														
Being taught how to follow a healthy diet														
Treatment, %	71.5	75.1	59.9	70.5	74.5	46.3	84.8	59.7	48.4	83.5	66.4	43.4	NA	NA
Control, %	46.6	64.8	53.7	55.6	41.2	24.4	32.8	51.1	42.5	71.0	45.5	29.9	NA	NA
Difference	24.9 ^c	10.3 ^c	6.2	14.9 ^c	33.4 ^c	21.8 ^c	52.0 ^c	8.6	5.9	12.5 ^c	20.9 ^c	13.5 ^c	NA	NA
Being taught how to exercise														
Treatment, %	57.9	61.7	62.9	54.0	62.2	40.9	66.7	58.9	52.2	80.5	55.6	31.4	NA	NA
Control, %	38.8	58.2	54.8	57.1	39.4	33.3	32.3	54.5	45.5	72.2	46.2	30.9	NA	NA
Difference	19.0 ^c	3.5 ^c	8.1 ^d	-3.1	22.9 ^c	7.6 ^e	34.4 ^c	4.4	6.6	8.3 ^d	9.4 ^d	0.6	NA	NA
Being taught how to take medication														
Treatment, %	70.3	77.9	80.9	83.4	73.3	62.9	71.8	75.4	70.9	79.9	85.5	58.2	NA	NA
Control, %	66.6	80.9	81.4	80.7	65.9	63.4	58.0	75.3	76.8	81.2	79.4	57.2	NA	NA
Difference	3.8	-3.0	-0.4	2.7	7.5 ^d	-0.5	13.8 ^c	0.2	-5.9	-1.3	6.1 ^e	1.0	NA	NA
Being taught warning signs to seek urgent care														
Treatment, %	61.8	61.9	57.2	63.2	68.4	37.0	53.7	50.8	41.5	76.0	52.8	33.9	NA	NA
Control, %	46.7	61.6	51.2	57.6	47.1	37.3	32.7	42.0	39.9	71.9	42.0	30.9	NA	NA
Difference	15.1 ^c	0.3	6.0	5.6	21.3 ^c	-0.3	21.0 ^c	8.8 ^e	1.5	4.1	10.8 ^c	3.0	NA	NA
Receiving materials to explain condition or treatment														
Treatment, %	82.5	78.2	53.8	86.2	83.8	53.7	78.6	56.3	38.5	74.9	69.9	74.2	NA	NA
Control, %	65.2	43.5	72.4	57.6	50.0	45.0	38.5	50.0	60.0	73.7	56.7	77.8	NA	NA
Difference	17.2 ^d	34.7 ^c	-18.6 ^d	28.6 ^c	33.8 ^c	8.7	40.1 ^c	6.3	-21.5 ^c	1.2	13.2 ^d	-3.6	NA	NA
Service Arrangement and Receipt of Assistance (From Patient Survey)														
Beneficiary reported receiving help in arranging care														
Treatment, %	77.3	54.7	62.1	59.1	65.9	73.6	75.5	74.4	66.2	56.8	80.6	30.3	NA	NA
Control, %	7.7	18.8	19.6	17.2	9.4	8.9	3.9	21.3	27.7	23.0	21.8	3.3	NA	NA
Difference	69.6 ^c	36.0 ^c	42.5 ^c	41.9 ^c	56.5 ^c	64.7 ^c	71.6 ^c	53.1 ^c	38.6 ^c	33.7 ^c	58.8 ^c	27.0 ^c	NA	NA
Beneficiaries needing help in any specified activities, received all help needed ^f														
Treatment, %	89.9	71.5	70.2	93.2	78.6	92.9	90.0	89.6	73.8	87.1	89.2	82.9	NA	NA
Control, %	88.0	66.1	72.1	90.3	77.4	90.8	84.1	82.6	74.6	79.6	95.2	79.0	NA	NA
Difference	1.9	5.4	-1.9	2.8	1.3	2.1	5.9	7.0	-0.9	7.6	-6.0	3.9	NA	NA
Provision of General and Disease-Specific Clinical Preventive Services (From Patient Survey and Medicare Claims Data)														
Reported receiving general preventive services (from patient survey)														
Influenza vaccine														
Treatment, %	87.3	69.7	76.4	89.2	82.6	93.9	87.4	77.9	82.6	82.8	82.8	80.7	NA	NA
Control, %	87.7	68.2	80.0	88.9	77.4	92.0	89.8	80.0	83.6	86.1	84.2	79.9	NA	NA
Difference	-0.4	1.5	-3.6	0.3	5.2 ^e	1.9	-2.4	-2.1	-1.0	-3.3	-1.4	0.8	NA	NA
Pneumococcal vaccine														
Treatment, %	88.9	64.6	69.8	78.4	80.8	83.3	84.7	78.0	64.8	74.3	82.2	73.1	NA	NA
Control, %	88.4	60.8	73.6	78.9	80.5	85.8	77.5	86.2	67.8	78.0	82.6	70.3	NA	NA
Difference	0.5	3.8	-3.8	-0.5	0.3	-2.6	7.2 ^d	-8.2 ^d	-3.0	-3.7	-0.4	2.8	NA	NA
Colon cancer screening														
Treatment, %	42.9	36.4	49.3	36.9	41.8	45.4	42.8	36.2	44.8	48.8	35.2	43.8	NA	NA
Control, %	42.1	41.3	47.0	37.2	41.5	45.8	36.6	39.5	44.7	49.6	36.7	43.8	NA	NA
Difference	0.8	-4.9	2.4	-0.3	0.3	-0.5	6.2	-3.3	0.2	-0.8	-1.5	-0.1	NA	NA

(continued)

Table 6. Process of Care Quality Indicators From Patient Survey and Medicare Claims Data^a (continued)

	Carle	CorSo- lutions ^b	Wash- ington Univer- sity	Avera	CenVa- Net	Charles- town	Health Quality Part- ners	Hos- pice of the Valley	Jewish Home and Hospi- tal	Medi- cal Care Devel- opment	Mercy Medi- cal Center	QMed	George- town Univer- sity	Univer- sity of Mary- land
Provision of General and Disease-Specific Clinical Preventive Services (From Patient Survey and Medicare Claims Data) (continued)														
General preventive services (from Medicare claims data ^g)														
Colon cancer screening ^h														
Treatment, %	23.7	14.9	22.5	14.8	24.4	35.2	32.7	19.5	21.7	25.0	16.7	32.4	16.6	11.8
Control, %	23.5	13.8	22.7	20.5	19.3	32.6	30.9	13.1	19.2	25.5	19.0	29.6	12.0	16.5
Difference	0.2	1.1	-0.2	-5.7 ^e	5.1 ^d	2.6	1.8	6.4 ^d	2.5	-0.5	-2.3	2.8	4.6	-4.7
Mammography (women only)														
Treatment, %	74.8	32.6	56.4	44.3	46.4	62.0	77.1	28.8	43.6	50.4	47.9	66.6	37.2	43.2
Control, %	71.2	34.1	57.3	43.7	47.5	49.6	72.2	37.0	44.0	48.5	44.7	68.5	20.8	43.5
Difference	3.6	-1.5	-0.9	0.6	-1.1	12.4 ^c	4.9	-8.2 ^e	-0.4	1.9	3.2	-1.9	16.4 ^e	-0.3
Preventive services for patients with diabetes ⁱ (from Medicare claims data ^g)														
Diabetes education														
Treatment, %	25.0	9.2	38.1	11.1	20.3	0.0	14.6	15.1	0.9	18.7	10.5	1.4	6.3	14.3
Control, %	22.0	11.4	33.8	10.0	16.9	4.4	17.7	9.2	0.9	15.4	12.0	0.7	6.7	16.3
Difference	3.0	-2.2	4.3	1.1	3.4	-4.4 ^d	-3.1	5.9	0	3.3	-1.5	0.7	-0.4	-2.0
Eye examination														
Treatment, %	86.5	75.8	85.2	87.4	90.4	96.5	87.8	76.7	92.1	94.6	97.8	88.4	81.7	65.2
Control, %	83.3	73.2	87.3	85.6	89.0	89.4	92.0	83.6	93.5	93.2	97.0	86.8	79.2	72.4
Difference	3.2	2.6	-2.1	1.8	1.4	7.1 ^e	-4.2	-6.9	-1.4	1.4	0.8	1.6	2.5	-7.2
Lipid testing														
Treatment, %	93.1	86.1	77.3	69.0	82.6	78.6	97.1	79.4	86.8	81.3	69.1	93.3	80.8	65.2
Control, %	86.9	77.6	77.6	62.9	84.1	78.0	94.6	70.7	79.3	85.2	63.1	94.2	77.2	67.4
Difference	6.2 ^c	8.5 ^c	-0.3	6.1	-1.5	0.6	2.5	8.7	7.5	-3.9	6.0	-0.9	3.6	-2.2
Hemoglobin A _{1c} testing														
Treatment, %	94.9	82.7	86.1	82.0	88.1	81.9	97.5	74.6	75.9	86.6	87.7	90.5	78.8	68.5
Control, %	94.7	77.9	86.0	80.8	88.3	78.7	92.8	81.3	73.2	89.9	86.1	90.1	77.5	66.5
Difference	0.2	4.8 ^d	0.1	1.2	-0.2	3.2	4.7 ^e	-6.7	2.7	-3.3	1.6	0.4	1.3	2.0
Urine microalbuminuria testing														
Treatment, %	81.0	25.8	27.9	19.8	33.4	9.9	61.6	31.3	21.3	38.2	19.3	47.5	31.1	14.3
Control, %	60.2	22.7	31.4	27.8	27.1	3.4	63.5	28.1	21.8	37.8	13.5	49.5	19.8	27.3
Difference	20.8 ^c	3.1	-3.5	-8.0	6.3 ^e	6.5 ^e	-1.9	3.2	-0.5	0.4	5.8	-2.0	11.3	-13.0
Preventive services for patients with CAD ⁱ (from Medicare claims data)														
Lipid test ^g														
Treatment, %	89.4	80.6	74.8	63.2	77.7	68.9	95.6	71.9	82.3	80.5	57.5	92.7	79.4	58.7
Control, %	82.5	74.6	72.8	56.0	79.4	70.3	93.0	65.5	74.9	83.3	55.0	90.5	78.3	68.6
Difference	6.9 ^c	6.0 ^c	2.0	7.2 ^e	-1.7	-1.4	2.6	6.4	7.4	-2.8	2.5	2.2	1.1	-9.9

Abbreviations: CAD, coronary artery disease; CMS, Centers for Medicare & Medicaid Services; NA, not available.

^aSurvey of patients conducted between May 2003 and June 2004, with program-specific response rates ranging from 85% to 98% and overall response rate of 95%; Medicare Enrollment Database; National Claims History File; and Standard Analytic File. Patients in the Georgetown and University of Maryland programs were not surveyed because of low enrollment and small sample sizes. The Quality Oncology program, which focused on optimizing cancer treatment for patients undergoing active treatment, is not shown because the listed quality measures do not apply to this program. For the claims-based outcomes, the sample exclusions and regression-adjustment methods are the same as in Table 4. The claims-based outcomes are calculated over 2-year follow-up for beneficiaries enrolled through June 2004, with sample members for which no event was observed given a weight proportional to the fraction of follow-up the beneficiary met CMS's demonstration-wide requirements and was alive, and cases for which an event was observed given a weight of 1. Results from the survey data are unadjusted comparisons of means, weighted with sampling weights.

^bSample sizes for the treatment and control groups differ for CorSolutions because this program originally planned to implement 2 separate treatment groups. To accommodate this design, 30% of enrollees were randomly assigned to each treatment group and 40% to the control group. However, 2 treatment groups actually received the same intervention and were therefore combined in the analysis.

^cSignificantly different at 2-tailed $P < .01$.

^dSignificantly different at 2-tailed $P < .05$.

^eSignificantly different at 2-tailed $P < .10$.

^fProportion of beneficiaries who received all needed help in all activities, among those reporting inability to independently do 1 or more of the following—use the telephone, transport oneself, shop, prepare meals, do housework, take medications, or handle money.

^gAt least 1 provision of the service during 2-year follow-up.

^hA claim for fecal occult blood testing, screening colonoscopy, sigmoidoscopy, or barium enema.

ⁱMedical conditions treated during the 2 years before randomization, as reported in Medicare claims data.

request). For this subgroup, both differences were large (-29% for hospitalizations and -20% for expenditures) and statistically significant ($P = .009$ and $P = .07$, respectively).

Despite these underwhelming results for care coordination interven-

tions in general, the favorable findings for Mercy and HQP suggest that the potential exists for care coordination interventions to be cost-neutral and to improve patients' well-being. Health Quality Partners' low fee was nearly fully offset by the treatment group's

lower regular Medicare expenditures, and based on the subgroup analyses these savings would have been substantially larger had the program targeted only the highest severity group. Mercy Medical Center had substantially higher fees (\$236 per member per

month) that were only partially offset by the lower Medicare expenditures for the treatment group (\$112 per member per month). However, if the sizeable reduction in hospitalizations could be achieved more efficiently, the program could be cost-effective. Unfortunately, despite the positive effects on patient education, patient behavior, functional ability, and quality of life were not improved.

A driving factor in CMS's initial decision to include many programs in the demonstration and allow them the flexibility to define their own interventions and target populations was the need to define which features of a care coordination program were important to improving outcomes. Comparing the 2 programs with the most positive results, HQP and Mercy, with the 10 unsuccessful programs with enough enrollees to yield credible estimates reveals 5 noteworthy differences. First, both of the successful programs averaged nearly 1 in-person contact per month per patient, far higher than the median of 0.3 for the 10 unsuccessful programs (only 2 of the unsuccessful programs averaged close to 1 in-person contact per month). Relatively frequent in-person contacts may be necessary to develop the level of trust that patients and their families need to consider the care coordinator an integral part of their care network and to confide in the coordinator and rely on his or her judgment. Second, these 2 programs had favorable effects on populations with average monthly Medicare expenditures of approximately \$900 and \$1200 in follow-up, whereas only 1 of the 10 unsuccessful programs enrolled a mix of beneficiaries with average Medicare expenditures in this range. This pattern suggests that programs may need to target patients who are neither at too low a risk of hospitalizations for the program to have effects in a 2- to 4-year follow-up, nor so seriously ill that it is too late for such interventions to ward off hospitalizations. Third, in both programs, treatment group members were significantly more likely than control group

members to report being taught how to take their medications (only 1 other program displayed such a difference). Fourth, care coordinators for both HQP and Mercy worked closely with local hospitals, which provided the programs with timely information on patient hospitalizations and enhanced their potential to manage transitions and reduce short-term readmissions. Finally, care coordinators in both programs had frequent opportunities to interact informally with physicians. Many physician practices from which HQP drew its patients made onsite space available for the care coordinator to meet with the patients privately before or after their visits. Similarly, care coordinators for Mercy, which served a rural area, frequently arranged to meet their patients in local clinics at the time of patients' appointments with their primary care physicians. Many of the care coordinators knew the physicians well, because all were employees of Mercy Medical Center. Both of these programs further strengthened the care coordinator-physician ties by assigning all of a given physician's patients to the same care coordinator whenever practical. Only 2 of the other 10 programs had both features, care coordinators co-located with physicians and a single care coordinator assigned to each physician's patients. The 2 programs also had the 2 highest researcher ratings on patient education, among all 15 programs. Unfortunately, despite these intensive programs, few substantial changes in patient behavior were observed.

Based on the findings from this study, CMS offered these 2 most successful MCCD programs the opportunity to continue their interventions for up to 3 additional years, with continuation depending on whether an interim evaluation shows evidence of persistent favorable effects. Both programs accepted. The fees at Mercy Medical Center were reduced to \$113 per member per month to match the savings it generated in Medicare expenditures during the demonstration period, less than half the average fee it received dur-

ing the demonstration. The interim results will be available in 2010.

The main limitation of this study is that the large variance in Medicare expenditures and (for some programs) low program fees resulted in only 4 sites having adequate power to detect reductions in standard Medicare expenditures large enough to offset the program fees (available upon request). Nevertheless, the sample sizes are larger than most published studies of care coordination and the estimates for hospitalizations clarify the conclusions regarding cost neutrality. In any case, it is clear that even if savings could be achieved they would be modest, even for the most successful programs. The strengths of the study are the use of a randomized design in each program and a considerably longer follow-up than any prior care coordination studies we have identified, as well as evaluation of 15 different interventions in different settings.

The mixed findings from the MCCD are more favorable than the negative results of 2 other efforts by CMS to introduce care coordination or disease management into Medicare fee-for-service—the Medicare Health Support⁶⁴ pilot program and the Medicare Disease Management Demonstration.⁶⁵ Although the programs participating in those 2 studies differ from the MCCD programs in that they are much larger and operated exclusively by commercial disease management companies, they had similar goals and target populations. None of those programs showed significant reductions in hospitalizations or Medicare expenditures.

Our results, when coupled with other recent evidence from the literature, suggest that the most effective intervention for care coordination would be a combination of an ongoing model such as that offered by Mercy and HQP, with a proven transitional care model to prevent hospital readmissions. Two proven transitional care models^{16,37,38} enroll patients while they are in the hospital and both have shown large reductions in readmissions within 30 or 60 days after discharge when the patient is at high

risk (18% of hospitalized Medicare beneficiaries are readmitted within 30 days), making this a potentially rewarding area for generating savings.⁶⁶ Neither the successful MCCD programs nor similar types of effective interventions^{39,40} have implemented structured interventions such as these when a hospitalization does occur—a time when patients with chronic illnesses are disoriented, receiving fragmented care, and at especially high risk of not understanding what they need to do to avoid a readmission. Thus, a hybrid model would seem to be more effective than either model in isolation and the 2 models would be logical complements.

These findings are relevant to recent policy interest in medical homes as a way to improve care coordination, improve quality, and reduce costs.⁶⁷ By providing close links between the patient's nurse coordinator and physician, substantial in-person contact between the patient and the care coordinator, and (presumably) timely information on hospital admissions, the medical home model may be able to replicate or exceed the success of the most effective MCCD programs. However, the modest benefits suggest that future research will need to determine how to more effectively improve patient outcomes. The successful interventions also may offer more detailed lessons for medical homes about how best to educate and monitor patients, the types of patients for whom they are likely to be most effective, and how to help patients overcome barriers to better self-care.

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Study concept and design: Peikes, Chen, Schore, Brown.

Acquisition of data: Peikes, Chen, Brown.

Analysis and interpretation of data: Peikes, Chen, Schore, Brown.

Drafting of the manuscript: Peikes, Chen, Schore, Brown.

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Additional Information: eTables 1 and 2 are available at <http://www.jama.com>.

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